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Teachers' beliefs, instructional behaviors, and students' engagement in learning from texts with instructional pictures

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Abstract

This study investigated the relations between teachers' pedagogical beliefs and students' self-reported engagement in learning from texts with instructional pictures. Participants were the biology, geography, and German teachers of 46 classes (grades 5 to 8) and their students. Teachers' instructional behaviors and students' engagement in learning from texts with instructional pictures were assessed by means of student ratings. Teachers' beliefs about using texts with instructional pictures in their teaching were assessed by a self-report questionnaire. Results showed that the more teachers believed that students should be taught clear strategies on how to learn from texts with instructional pictures the more engagement was reported by their students. A multilevel mediation model showed that the association between teachers' beliefs and students' self-reported engagement was mediated by teachers' perceived instructional behavior.

Keywords: Engagement in learning; Teacher beliefs; Instructional behaviors; Texts with instructional pictures

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1. Introduction

Most school textbooks contain instructional pictures such as flow charts, diagrams, and graphs (Mayer, 2001). The ability to integrate the information contained in the pictures with the information presented in the text is a critical condition for learning to occur (Ainsworth, 2006; Schnotz & Bannert, 2003). According to Mautone and Mayer (2007), many students have difficulties understanding graphs and have considerable misconceptions about their interpretation. For example, Gobbo (1993) found that a substantial proportion of 12-year-olds were unable to read off the values reported in simple line graphs or to describe the information presented in charts. Unfortunately, many teachers are unaware of the problem that their students may have difficulties with instructional pictures. Indeed, the text-picture integration is not systematically taught in teacher education programs in Germany, and the ability to interpret these pictures is not recognized as an important instructional goal (Houghton & Willows, 1987; McElvany, Schroeder, Hachfeld, Baumert, Richter, Schnotz, Horz & Ullrich, 2009; Seufert, 2003).

A related problem is that teachers are not trained to motivate their students to engage in learning from texts that contain instructional pictures. Why is motivation important in this context? Most elementary school textbooks include representational pictures such as photographs or line drawings that illustrate the overall theme of the text and situate learning. Their major function is not to communicate information, but to keep students interested and to assist their comprehension (Carney & Levin, 2002). In secondary education, in contrast, the major function of instructional pictures is to convey additional information not provided by the text. The pictures can be realistic or schematized and exhibit various degrees of abstraction (e.g., photographs, tables, graphical representations). The interpretation of logical pictures—highly schematized pictures that do not look like the things they represent but are to be interpreted in some conceptual or logical way—is a case in point. Similar to complex realistic pictures, logical pictures make high cognitive demands of learners. Students are required to actively invest the mental effort needed to process the picture (Scheiter, Gerjets, Huk, Imhof, & Kammerer, 2009). From this perspective, it is crucial that teachers motivate students to engage in learning with instructional pictures.

1.1. Relations between teachers' beliefs and students' engagement in learning

Throughout this article, we conceptualize students' motivation to learn from instructional pictures in terms of engagement. Motivational engagement refers to the intensity and emotional quality of students' involvement in a learning task (Reeve, Jang, Carrell, Jeon, & Barch, 2004; Skinner & Belmont, 1993). It is a rather broad construct that is related to other motivational variables, such as intrinsic motivation, self-directed behavior, interest, and involvement, and which has emotional, behavioral, and cognitive aspects (Turner, Meyer, Cox, Logan, DiCintio, & Thomas, 1998). Engagement is typically accompanied by positive emotions such as curiosity and interest. Cognitive and behavioral aspects of engagement include task-directed attention, cognitive involvement, and higher levels of persistence (Schiefele, Krapp, & Winteler, 1992).

A great deal of research has investigated how aspects of the instructional setting

such as teachers' behaviors influence students' engagement (Deci, Vallerand, Pelletier, & Ryan, 1991). For example, it has been shown that instructional settings that satisfy students' needs for autonomy and competence are perceived as more motivating and rewarding (Ryan & Deci, 2000). Additional research has established that whether and to what extent students engage in learning tasks also depends on their teachers' beliefs (Woolfolk-Hoy, Davis, & Pape, 2006). This research has focused primarily on two kinds of beliefs. First, teachers differ in whether and to what extent they believe that students should learn independently and generate their own solutions to problems. Second, teachers differ in whether and to what extent they believe that students should be given direct instruction on how to use specific strategies, provided with structured learning materials, and offered sufficient opportunities to practice newly acquired strategies with reinforcing feedback. As Stefanou, Percencevich, DiCintio, and Turner (2004) have argued, structure and instructional guidance can enhance students' engagement (see also Alonso-Tapia & Pardo, 2006). If students do not possess the prior knowledge and cognitive skills required for a task, too much emphasis on self-regulated learning can induce cognitive overload. In such cases, it is essential to provide instructional support and scaffolding.

On a general level, this argument is in line with studies showing that direct instruction and effective classroom management can enhance students' intrinsic motivation and task engagement. For example, Skinner and Belmont (1993) reported positive effects of the degree of instructional structure on students' engagement. Similarly, Kunter, Baumert, and Köller (2007) have shown that students' perceptions of teacher monitoring and rule clarity are positively related to interest development. More specifically, Tsai, Kunter, Lüdtke, Trautwein, and Ryan (2008) demonstrated that teachers can support students' situational interest by making the aims of a learning task explicit and by providing them with concrete task-related strategies.

1.2. Instructional strategies for enhancing comprehension of texts with instructional pictures

Although many teachers are largely unaware of the importance of the text-picture integration, there can be no doubt that students require instructional support in developing the ability to interpret pictures in texts (Bartholomé & Bromme, 2009). A general problem is that pictures—unlike written texts—can be processed very rapidly to gain a rough impression of the information conveyed. Due to this subjective ease of encoding, learners often have the metacognitive illusion of understanding instructional pictures fully and focus solely on textual information, with negative consequences for learning (Peeck, 1994; Weidenmann, 1989).

Beyond revealing students' difficulties in understanding the pictures used in instructional texts, research has shown that explicit picture-oriented instruction provides effective measures to counter these problems (Peeck, 1994; Weidenmann, 1989). Peeck (1993) provided a list of concrete instructional interventions to support this process. This list includes asking students to pay attention to pictures, telling them what to look for in a particular picture, and instructing them to do something with the picture (comparing, labeling, completing graphs, etc.), with or without a controllable product. In a similar

vein, several studies have shown that scaffolding and cueing techniques that guide learners' actions (e.g., signaling devices, structural organizers, and strategy prompts) can be used to improve students' comprehension of graphs and pictures (Mautone & Mayer, 2007; Seufert, 2003; see, also, Bartholomé & Bromme, 2009).

1.3. The present study - Hypotheses

The present study investigated, first, whether teachers' beliefs about learning from text with instructional pictures are associated with students' self-reported engagement in learning from instructional pictures; second, whether the relations of teachers' beliefs with students' engagement are mediated by teachers' instructional behaviors as perceived by their students.

1.3.1. Teachers' beliefs and students' engagement in learning from texts with instructional pictures

The bottom line of research on text-picture integration seems to be that forms of direct instruction are most effective in fostering comprehension of texts with instructional pictures (Peeck, 1994). To date, it remains unclear whether these instructional strategies also foster students' engagement when it comes to learning from texts that contain instructional pictures. In the present study, we were interested in the relationship between students' engagement in learning from texts with instructional pictures and teachers' beliefs that (a) students should be taught clear strategies how to deal with text with instructional pictures, and that (b) they should deal with this kind of pictures independently. Accordingly, the following hypotheses were tested:

There should be a positive relationship between students' engagement and teachers' beliefs that students should be taught clear strategies for learning from text with instructional pictures (Hypothesis 1a). On the contrary, there should be a negative relationship between students' engagement and teachers' beliefs that students should learn to interpret the text-picture relationship independently (Hypothesis 1b). Moreover, teachers differ in their sensitivity to the fact that their students have difficulties to learn from such texts. Therefore, two further belief scales were included in the present study which assessed whether teachers believed that instructional pictures are useful for their teaching and that it is important to practice them in their lessons. For both types of beliefs, positive relationships with students' engagement were expected (Hypothesis 1c).

To clarify whether the results of the study are specific to the domain of instructional pictures, teachers' beliefs about texts that contain instructional pictures were compared with their beliefs about text reading in general. More specifically, it was expected that the above predicted relationships between teachers' beliefs and students' engagement would pertain only to the domain of instructional pictures but not to beliefs about text reading in general (Hypothesis 2).

1.3.2. The mediating role of teachers' instructional behaviors

Previous research has shown that teachers' beliefs are not directly related to student outcomes but mediated by their instructional behavior (see Woolfolk-Hoy et al.,

2006, for a review). For example, Stipek, Givvin, Salmon, and MacGyvers (2001) have demonstrated that teachers' beliefs are generally consistent with their instructional behaviors and influence the criteria by which they evaluate their students. In addition, Dubberke, Kunter, McElvany, Brunner, and Baumert (2008) as well as Baumert, Kunter, Blum, Brunner, Voss, Jordan et al. (2010) have shown in a longitudinal study (Grades 8-9) that teachers' beliefs and knowledge were associated with students' achievement one year later and that these relations were mediated by teachers' instructional behaviors.

In the present study, we assessed students' perceptions of three instructional behaviors similar to those that have been found to have positive relations with student outcomes in previous studies (Baumert et al., 2010; Dubberke et al., 2008; Kunter, Baumert, et al., 2007; Tsai et al., 2008): (a) teachers' classroom management skills, (b) the lesson time teachers spend discussing and reviewing texts containing pictures, and (c) teachers' use of adaptive explanations to support learning from those texts. The following hypotheses about the relations between teachers' beliefs, their perceived instructional behavior, and students' self-reported engagement were tested:

Teachers' belief that students should be taught clear strategies for learning from texts with instructional pictures will be positively associated with all aspects of teachers' instructional behavior, whereas the belief that students should learn to interpret the text-picture relationship independently will be negatively associated with all aspects of instructional behavior (Hypothesis 3). Furthermore, all aspects of teachers' instructional behavior will be positively associated with students' engagement in learning from texts with instructional pictures and will mediate the relation of teachers' beliefs with students' engagement (Hypothesis 4).

It must be noted from the outset that the present study was based on a cross-sectional correlational design. For this reason, despite the fact that the term "causal steps approach" implies a certain causal sequence of the predictors included in the model tested, caution is warranted in making causal interpretations of the results. This issue will be discussed more thoroughly in the Discussion.

2. Method

2.1. Sample

The sample comprised students from 48 classes and their biology, geography, and German teachers. Each class came from a different school. Schools were drawn randomly from the total population of all secondary schools in Rhineland-Palatinate, Germany, namely 16 academic-track schools (Gymnasium), 16 intermediate-track schools (Realschule), and 16 vocational-track schools (Hauptschule). One class of Grade 5, 6, 7, or 8 was then drawn randomly within each school, and that class's biology, geography, and German teachers were invited to participate in the study. Teachers in two schools (one academic- and one vocational-track school) refused to participate in the study. Thus, on the class level our final sample comprised 46 classes from 46 schools.

The 46 classes were taught by 116 different teachers. Eight teachers (6.9%) did not return the teacher questionnaire or provided insufficient data. As a result, on the teacher level the final sample consisted of 108 teachers (67 women). Of them 33 were

biology teachers, 33 geography teachers, and 42 German teachers. The mean age of the teachers was 44.4 years (SD = 11.3), whereas their mean years of teaching was 16.6 (SD = 11.4).

On the student level, 1026 students from the 46 classes participated in the study (M = 22.3 students per class, SD = 4.7). A third of the students in every class rated their engagement in one of the three school subjects and provided ratings of the corresponding teacher's instructional behavior. Sixteen teachers taught two school subjects to the same class. These teachers completed the questionnaire only for their main school subject, and only the student ratings of their main school subject were included in the data set. Thus, results were drawn on ratings from 856 students (50% female, 48% male, and 2% did not specify gender). The mean age of the students was 13.2 years (SD = 1.3), whereas they provided a mean of 7.9 ratings per teacher (SD = 2.3).

2.2. Measures

2.2.1. Teacher beliefs for learning from texts with instructional pictures

Teachers responded to a questionnaire constructed specifically for the present study (McElvany et al., 2009). Items were based on an existing questionnaire assessing teacher beliefs in the domain of mathematics (see the COACTIV project study by Kunter, Klusmann, et al., 2007). One block of items assessed teachers' pedagogical beliefs in the domain of text–picture comprehension. These items measured teachers' general beliefs about instruction based on texts with integrated pictures independent of the base-rate of their usage in a given school subject. Rather, the items were intended to capture individual differences between teachers. Teachers rated their agreement with 14 statements on a 4-point Likert-type scale anchored at 1 (strongly disagree) and 4 (strongly agree).

The items were considered a priori to reflect four different kinds of beliefs. First, the Utility of Pictures scale assessed the degree to which the teachers considered pictures to be useful for instruction in general and their own teaching in particular. Second, the Importance of Practice scale measured teachers' beliefs about the importance of giving students explicit practice in processing instructional pictures. Third, the Independent Learning scale assessed the degree to which teachers believed that their students should develop their own interpretations of texts with instructional pictures and resolve comprehension difficulties independently. Fourth, the Strategy Use scale measured teachers' endorsement of the belief that students should learn clear strategies, schemes, and routines for interpreting new and complex pictures. Table 1 provides sample items, reliabilities, descriptive statistics, and intercorrelations for the four belief scales on text-picture comprehension.

Insert Table 1 about here

A confirmatory factor analysis with intercorrelated factors (Figure 1) showed acceptable model fit, $\chi^2(71, N = 108) = 111.82$, $p < .05$, CFI = .912, RMSEA = .073. The internal consistencies of the four scales ranged from acceptable to good (see Table 1). Most of the correlations between the scales were weak, indicating that they indeed

measure independent constructs.

Insert Figure 1 about here

2.2.2. Teachers' beliefs for text reading

A second block of items similar to the one on texts with instructional pictures measured teachers' beliefs about reading texts without instructional pictures. The Importance of Practice, Independent Learning, and Strategy Use scales were identical to the belief scales on text-picture comprehension except that they did not refer to picture comprehension in particular but to text reading in general. The Utility of Pictures scale, in contrast, was replaced by a Fostering Reading Competence scale that assessed the degree to which teachers believed that promoting students; reading competence is an explicit aim of their teaching. Table 2 provides sample items, reliabilities, descriptive statistics, and intercorrelations of the four belief scales on text reading. A confirmatory factor analysis with intercorrelated factors showed that the fit of the model was not satisfactory, $\chi^2(98, \underline{N} = 108) = 207.04$, $\underline{p} < .01$, CFI = .817, RMSEA = .102. However, the internal consistencies of the four scales were generally good and the belief scales on text reading correlated only weakly with each other (see Table 2).

Insert Table 2 about here

2.2.3. Frequency of instructional picture use

Two items in the teacher questionnaire assessed how frequently teachers used pictures as instructional materials in their classes. First, teachers were asked to estimate the percentage of lessons and homework assignments in which they used texts with instructional pictures. On average, teachers responded that they used instructional pictures in approximately half of their lessons ($\underline{M}$ = 52.1%, $\underline{SD}$ = 30). and in one third of their homework assignments ($\underline{M}$ = 35.2%, $\underline{SD}$ = 26.8). The two-item scale had high internal consistency (Cronbach's α = .86). As a consequence, the two ratings were aggregated to one overall index of teachers' quantity of instructional picture use.

2.2.4. Perceived instructional behaviors

Teachers' instructional behaviors were assessed by means of student ratings (Kunter & Baumert, 2006) in a questionnaire constructed specifically for the present study. Again, the items were based on measures from the COACTIV project study (Kunter, Klusmann, et al., 2007). The student ratings were intended to assess the teacher's behavior related to instructional pictures independent of the base-rate of their usage in a school subject. Therefore, the general prompt for all items was "Please think about what it is like <u>when</u> you read texts with pictures in your biology class" (emphasis added). Students rated their agreement with 14 statements concerning the instructional behaviors of one of their teachers on a 4-point Likert-type scale anchored at 1 (strongly disagree) and 4 (strongly agree). In the present study, the focus was on three scales measuring different aspects of teaching behavior. First, the Classroom Management scale

assessed the general level of disruption in the classroom. Second, the Discussion Time scale measured the amount of time teachers spent discussing and reviewing texts containing instructional pictures when they used such texts in their lessons. Third, the Adaptive Explanations scale assessed the teachers' provision of support and instructional guidance for students when they used these texts in their lessons. For each teacher, students' ratings were aggregated to obtain reliable measures of the teacher's instructional behavior that are independent of the individual student (Kunter & Baumert, 2006). The homogeneity of students' rating for each teacher was checked by computing intraclass correlations (ICC; see Raudenbush & Bryk, 2002). The intraclass correlations were generally high which justifies their aggregation (ICC = .82 for classroom management, ICC = .60 for discussion time, and ICC = .72 for adaptive explanations).

Insert Table 3 about here

Table 3 provides an overview of the perceived instructional behavior scales, with sample items, reliabilities, descriptive statistics, and intercorrelations. A confirmatory factor analysis with intercorrelated factors (Figure 2) confirmed that the three theoretically proposed scales could be reliably distinguished, $\chi^2(74, \underline{N} = 108) = 116.33$, $\underline{p} < .01$, CFI = .969, RMSEA = .073. The three scales showed very good internal consistencies correlated moderately with one another (see Table 3).

Insert Figure 2 about here

2.2.5. Engagement in learning from texts with instructional pictures

Four items tapped students' general engagement in learning activities involving texts with pictures. Our engagement scale concentrated on the emotional aspects of engagement (Reeve & Jang, 2006; sample item: "We are very enthusiastic when reading texts with integrated pictures in our biology classes."). Affective variables such as positive affect and feelings of enjoyment are especially well suited for student ratings because they are highly accessible and easy to detect. The scale consisted of newly developed items asking students whether they found instructional texts that include pictures fun and inspiring. The resulting scale showed good internal consistency (Cronbach's $\alpha = .79$; $\underline{M} = 2.34$, $\underline{SD} = 0.73$).

2.3. Procedure

The teacher questionnaires were sent to a school representative, who distributed them to the teachers of the selected class. Teachers were asked to complete the questionnaire independently and to return it on the day their students were assessed. They were told that there were no correct or incorrect responses and that we were interested in their personal views. They were informed that the aim of the study was to enhance the teaching of texts with integrated pictures. Teachers were assured that participation was voluntary and that their answers would remain anonymous and confidential. The questionnaire also incorporated measures not reported here. Teachers took approximately

45 minutes to complete the questionnaire. In addition, their knowledge and skills of text-picture comprehension were assessed in a separate session (see McElvany et al., 2009). They were paid €45 for their participation in the study.

On a separate day, students were assessed by trained research assistants in regular lesson time. We first tested their ability to integrate information from pictures and texts and their general cognitive abilities. Subsequently, we administered a questionnaire measuring student engagement and teachers' perceived instructional behaviors. Students rated their biology, geography, or German teacher with different versions of the questionnaire being randomly assigned to students. Students were informed that there were no correct or incorrect responses and asked to provide their personal opinions on their teacher's instruction. Students participated voluntarily and parental consent was obtained prior to the study. Finally, several questions tapping students' socio-demographic and general in-school behavior were administered.

3. Results

3.1. Missing data

Only 0.6% of data points were missing at the teacher level and 1.0% at the student level. Missing values did not show any systematic pattern and were likely to be missing at random (MAR). To avoid loss of power due to listwise deletion, we used a multiple imputation procedure to handle the missing data. Teacher-level and student-level variables were imputed separately using the mice package in R 2.9.2 (van Buuren & Groothuis-Oudhoorn, in press). All other items in the questionnaire were used in the imputation model. Five imputed data sets were generated and analyzed separately. Results were combined using Rubin's rule (Rubin, 1987).[1] All effects were tested on an alpha level of .05 and applied the Bonferroni correction to all post hoc comparisons.

3.2. Descriptive statistics

3.2.1. Frequency of instructional picture use

There were huge differences in the overall frequency of picture use between the three school subjects, $F(2,105) = 40.1$, $p < .01$, partial $\eta^2 = .43$. Whereas instructional pictures were used infrequently in German classes ($M = 21.8\%$, $SE = 3.1$), they were more frequently used in biology and geography classes ($M = 55.8\%$, $SE = 3.5$ and $M = 59.5\%$, $SE = 3.5$, respectively). The differences between German classes on the one hand and biology and geography classes on the other hand were significant ($p < .01$) but the difference between biology and geography classes was not ($p = .46$). Frequency of

[1] Rubin's rule is a statistical formula for pooling parameters and standard errors in multiple imputation analyses. Generally, the population parameter is simply the mean of the individual parameters (i.e., regression coefficients) from all sets of imputations. However, computation of the standard error of the population parameter is more complicated. Basically, it is estimated as the sum of the mean of the estimates for the standard errors within all imputations and the weighted variability of these estimates between imputations (see Rubin, 1987, for details).

instructional picture use did not vary with school type or grade (both $\underline{F} < 1$, ns).

3.2.2. Student ratings

Students' ratings of their engagement in learning from texts with instructional pictures and teachers' instructional behaviors did not vary significantly with school subject, namely for classroom management, $\underline{F}(2,105) < 1$, ns; for discussion time, $\underline{F}(2,105) = 1.3$, ns; for adaptive explanations, $\underline{F}(2,105) = 1.2$, ns; and for engagement: $\underline{F}(2,105) < 1$, ns. At first glance, this result may be surprising given that texts with instructional pictures are more frequently used in biology or geography than in German classes. However, it is important to keep in mind that the perceived instructional behavior scales assessed the quality, but not the quantity of teachers' text-picture related instruction. That is, the scales were intended to measure the way teachers deal with text-pictures independent of the base rate of their usage in a given school subject.

3.2.3. Teachers' beliefs

Three scales for assessing teachers' beliefs about text-picture comprehension corresponded to three scales for assessing their beliefs about text reading in general (importance of practice, independent learning, and strategy use). In fact, the wording of the items of these scales was identical except for their focus on one of the domains. This allowed us to adopt an intra-individual perspective and compare teachers' beliefs between the two domains. In a first step, it was tested whether teachers dispose a general set of beliefs that guides their teaching in all school subjects or whether teachers' beliefs are specific for learning from texts with instructional pictures in particular. Table 4 shows the correlations between the three identical belief scales on text-picture comprehension and text reading.

Insert Table 4 about here

There were substantial pairwise correlations between corresponding scales (see the correlations on the main diagonal of the correlation matrix). Thus, there was some overlap between teachers' beliefs about text-picture comprehension and text reading in general, indicating that teachers' pedagogical beliefs might be domain-independent to some degree (Pajares, 1992). However, despite being substantial, the correlations were far from being perfect (even their latent correlations never exceeded $\underline{r} = .65$). In line with this observation, likelihood ratio tests (i.e., χ^2 difference tests) rejected the hypothesis that the latent pairwise correlations of beliefs about the two domains equal 1.0; for all comparisons $\Delta\chi^2(1) > 28$, $\underline{p} < .001$. Thus, teachers' general pedagogical beliefs were modulated by the characteristics of the school subject they are teaching (van Driel, Bulte, & Verloop, 2007).

Next, it was tested whether teachers of different school subjects differed in their beliefs in the two domains by means of repeated measurements ANOVAs with Domain (text-picture comprehension vs. text reading) as a within subjects factor and School Subject (German vs. biology vs. geography) as a between subjects factor.

For the Importance of Practice scale score as dependent variable, there was a main effect of domain, $\underline{F}(1,105) = 12.62$, $\underline{p} < .01$, partial $\eta^2 = .11$. Overall, teachers believed

that practicing text reading in general (M = 3.54, SE = 0.04) is more important than practicing text-picture comprehension (M = 3.35, SE = 0.05). However, this main effect was qualified by a significant interaction of domain with school subject, F(2, 105) = 3.84, p < .05, partial η^2 = .07. On average, German and biology teachers believed practicing text reading in general as being more important than practicing text-picture comprehension (German: M = 3.65 vs. M = 3.32, p < .01; biology: M = 3.47 vs. M = 3.25, p < .05). Geography teachers, in contrast, believed practicing to be of equal importance in both domains (M = 3.47 vs. M = 3.49, p = .87).

For the Independent Learning scale score as dependent variable, there was also a main effect of domain, F(1,105) = 5.28, p < .05, partial η^2 = .05. Teachers endorsed the belief that students are able to interpret texts with integrated pictures on their own (M = 3.31, SE = 0.05) to a greater extent than the belief that they are able to interpret texts without pictures (M = 3.19, SE = 0.06).

For the Strategy Use scale score as dependent variable, there were no overall differences between the two domains (F < 1, ns) but a significant interaction with school subject, F(2, 105) = 3.63, p < .05, partial η^2 = .07. On average, German and biology teachers believed that strategy use is of equal importance in both domains (German: M = 3.01 vs. M = 3.05, p = .56; biology: M = 3.15 vs. M = 3.02, p = .09). Geography teachers, in contrast, believed that strategy use is more important for texts with instructional pictures (M = 3.04 vs. M = 3.26, p < .05). In sum, the three kinds of beliefs were of differential importance for the two domains, and this effect was moderated by the school subject the teachers taught.

3.3. Multilevel mediation model

The hypotheses of the study can be summarized as a multilevel mediation model with teachers' beliefs as predictor variables and their instructional behaviors, as rated by their students, as mediator variables at Level 2 (teacher level) and students' self-reported engagement as the outcome variable at Level 1 (student level; see Figure 3). Because each class was taught by several teachers, we introduced a third level (class level) to control for class effects. Technically, the model is an upper-level mediation model (Krull & MacKinnon, 2001). It can be tested by an adaptation of the causal steps approach proposed by Baron and Kenny (1986). According to this approach, a mediator relationship can be assumed if (a) the antecedent variables (teachers' beliefs) is related to the outcome variable (students' engagement), (b) the antecedent variables explains variance in the mediating variables (perceived instructional behaviors), (c) the mediating variables are associated with the outcome variable, and (d) the relationships of the antecedent variables on the outcome variable are reduced in size when the mediating variables are controlled for. We specified a series of three-level random intercept models in which the intercept is allowed to vary randomly between units on the upper levels (teachers and classes), but all other effects are assumed to be fixed (Raudenbush & Bryk, 2002). The models did not contain any predictor variables on the class level (Level 3), but allowed the intercepts of classes to differ. In addition, because teachers' beliefs have been shown to vary with school subject, we included teachers' school subject as a control variable on the teacher level. All parameters were estimated using the restricted

maximum likelihood algorithm implemented in HLM 6.

Insert Figure 3 about here

3.3.1. Step 1: Relationships between teachers' beliefs and students' self-reported engagement

In the first step of the mediation analysis, it was tested whether teachers' beliefs (the antecedent variables) were related to students' self-reported engagement in learning activities involving text–picture comprehension (the outcome variable). To this end, a three-level random intercept model was estimated with students' engagement ratings as a criterion variable at Level 1 (student level) and the score of all four teacher belief scales as predictors at Level 2 (teacher level; Table 5, Model 1). In this model, the belief that students should be taught clear strategies for interpreting texts with instructional pictures was positively associated with students' engagement ratings. At the same time, the belief that students should interpret texts with integrated pictures independently was negatively associated with students' engagement ratings. Students' engagement ratings varied substantially between teachers (5% of the variance) as well as between classes (8%). In comparison to an unconditional model, inclusion of the belief variables reduced the total variance by 2%, the variance at the teacher level by 10%, and the variance at the class level by 12%.

Insert Table 5 about here

Thus, in line with Hypothesis 1a and 1b, the belief that students should be taught clear strategies for interpreting texts with instructional pictures positively predicted students' self-reported engagement to learn from text with instructional pictures; the belief that students should develop independently their own interpretations of pictures in texts negatively predicted students' engagement. However, no significant associations were found between students' engagement and teachers' more general beliefs about the utility of pictures in instructional texts or the importance of practice contrary to Hypothesis 1c.

3.3.2. Step 2: Relationships between teachers' beliefs and their perceived instructional behaviors.

In the second step of the mediation analysis, it was tested whether teachers' beliefs were related to their instructional behaviors as rated by their students. Accordingly, three two-level random intercept models were estimated with aggregated classroom management, discussion time, and adaptive explanation ratings as criterion variables and the scores on the four teacher belief scales as predictor variables (Table 6).

Insert Table 6 about here

In sum, the findings provide evidence that teachers' self-reported beliefs were

associated to their instructional behaviors as rated by their students. Overall, the pattern of results support Hypothesis 3, namely the belief that students should be taught clear strategies was associated with better classroom management, more discussion time, and more adaptive teacher explanations. In contrast to Hypothesis 3, the belief that students should interpret texts with instructional pictures independently was associated with less time spent discussing pictures and fewer adaptive teacher explanations, as predicted, but was not associated with teachers' classroom management. In addition, there were two unpredicted relationships: Both the belief that the processing of texts with instructional pictures should be practiced in class and the belief that instructional pictures are important were associated with less discussion time.

3.3.3. Step 3: The mediating role of perceived instructional behaviors.

In the final step of the mediation analysis, it was investigated whether the associations between teachers' beliefs and students' engagement ratings were mediated by teachers' perceived instructional behavior. To this end, a three-level random intercept model was estimated with students' self-reported engagement in text–picture comprehension as the criterion variable on Level 1 (student level) and the teacher belief scales and the instructional behavior scales as predictors on Level 2 (teacher level) while controlling for common classroom characteristics on Level 3 (full mediation model, Table 5, Model 2).

In partial support of Hypothesis 4, two of the three aspects of teachers' perceived instructional behavior included in the full mediation model were significantly associated with students' engagement ratings. The more teachers were able to manage their classes and the more time they spent on giving adaptive explanations the more engagement was reported by their students. In contrast, discussion time was not associated with students' engagement ratings. The second important finding was that the association between teachers' beliefs and students' engagement ratings were substantially reduced and no longer significant when the three instructional behavior scales scores were included in the model. According to the causal steps approach (Baron & Kenny, 1986), these results suggest that the effects of teachers' beliefs on students' self-reported engagement were fully mediated by teachers' perceived instructional behaviors as predicted by Hypothesis 4. In addition, including the instructional behavior ratings in the model considerably reduced the unexplained variance in students' engagement ratings. The instructional behavior ratings accounted for 25% of the total variance (16% of the variance at the student level, 92% of the variance at the teacher level, and 72% of the variance at the class level).

In addition to investigating mediation using the causal steps approach, we estimated the size of the 4 x 3 possible indirect relationships between teachers' beliefs and students' self-reported engagement in learning from texts with instructional pictures and tested whether they were significantly different from zero using Sobel's z-test (Krull & MacKinnon, 2001). In these analyses, the positive association of the belief that students should be taught clear strategies and students' self-reported engagement was mediated by better classroom management and a larger amount of adaptive explanations provided by the teacher (Table 7). In contrast, the negative association between the belief that students should develop interpretations of texts containing pictures independently

and students' self-reported engagement was only mediated by a smaller amount of adaptive explanations.

Insert Table 7 about here

3.3.4. Beliefs about text reading in general

To test Hypothesis 2 and establish that the reported pattern of results were indeed specific for teachers' beliefs about learning from texts with instructional pictures but not due to their pedagogical beliefs in general, a second analysis was conducted with teachers' beliefs on general text reading (e.g., on the scores of the scales Fostering Reading Competence, Importance of Practice, Independent Learning, and Strategy Use) as predictor variables and students' engagement as the outcome variable. All of the regression coefficients were not significant and small. Importantly, in contrast to the analysis with beliefs on learning from texts with instructional pictures, the Independent Learning scale was completely unrelated to students' engagement ratings. Only the belief that students should be taught fixed strategies was positively associated with students' engagement ratings ($\gamma = 0.12$, $\underline{SE} = 0.06$). However, even this regression coefficient did not reach significance, $\underline{t}(101) = 1.88$, $\underline{p} > .06$. Thus, in line with Hypothesis 2, there was little evidence that teachers' beliefs about general text reading were associated with students' engagement ratings on text with instructional pictures.

4. Discussion

Studies on learning from texts with instructional pictures indicate that text–picture integration makes high cognitive demands on learners. Accordingly, students benefit from direct instruction offering concrete task-related strategies (Peeck, 1993). In the present study, it was investigated (a) whether teachers' pedagogical beliefs about text-picture comprehension are related to students' engagement in learning from texts with instructional pictures and (b) whether these relationships are mediated by teachers' perceived instructional behaviors.

To this end, a multilevel mediation model was estimated with teachers' pedagogical beliefs in the domain of learning from texts with instructional pictures as distal predictors, students' engagement as the outcome variable, and aspects of teachers' perceived instructional behavior as mediator variables. Consistent with the hypothesized relationships, students' self-reported engagement was positively related to teachers' beliefs that students should be taught clear strategies for learning from text with integrated pictures. In contrast, self-reported engagement was negatively related to teachers' beliefs that students should learn to interpret the text–picture relationship independently. The relationships between teacher beliefs and student engagement were moderate and did not always reach significance.

Second, the mediation analysis showed the association between teachers' beliefs and students' self-reported engagement to be completely mediated by teachers' instructional behaviors. As expected, teachers' perceived instructional behavior was strongly and positively related to students' engagement. The more their teachers were

able to manage their classes and the more they gave adaptive explanations, the higher was students' reported engagement. The mediator analyses revealed that the relationship between teachers' beliefs concerning the use of clear strategies and students' self-reported engagement was attributable to teachers' classroom management skills and their amount of adaptive explanations. In contrast, the negative association between teachers' beliefs concerning independent learning and students' engagement ratings could only be attributed to teachers' amount of adaptive explanations. It is important to note that no such effects were obtained for teachers' pedagogical beliefs on text reading in general. Thus, we can be reasonably sure that the results reported here are specific for the domain of learning from texts that contain instructional pictures.

Unexpectedly, teachers' beliefs that students should be given explicit practice in interpreting texts with instructional pictures and that these texts are important for their lessons were not associated with students' self-reported engagement. At the same time, it was found that both types of beliefs were negatively associated with teachers' tendency to discuss these kinds of texts in their classes. How can these rather paradoxical results be explained? One possibility is that teachers tend to make the same mistake as their students and undervalue the informational complexity of instructional pictures (Peeck, 1993; Weidenmann, 1989). In line with the idea that a picture is worth a thousand words, some teachers might believe that instructional pictures are an effective and easily understood means of conveying complex information, ignoring the need to check that their students are actually able to extract and use the information contained in the picture. As a result, they neglect to discuss them in their classes.

One major limitation of our study is due to the fact that it is based on a correlational design. As a consequence, it is not possible to draw strong causal conclusions from the results reported. On the one hand, the mediation analyses provide some evidence that the hypothesized chain from teachers' beliefs via instructional behaviors to students' engagement in text-picture integration is consistent with the data. On the other hand, these results cannot rule out the possibility that the reported effects are in fact caused by unobserved confounding variables. For example, teachers who believe more strongly in strategy use might simply be more efficient in teaching picture-related materials. As a consequence, they might need less time to communicate the essential meaning to their students. Further studies are needed to clarify this issue. Ideally, such a study would follow an experimental design. For example, one possibility would be to manipulate teachers' beliefs and/or their instructional behaviors by appropriate training interventions. If the relationships suggested by the present results hold and if it is possible to design effective trainings, such interventions may be expected to exert positive effects on students' engagement in text-picture integration.

A second limitation is that the focal constructs of our study have all been assessed with global and retrospective self-report data. Clearly, self-report data are the method of choice for assessing teachers' beliefs. With regard to instructional behavior, multi-method studies have shown that aggregated student ratings can be a reliable and valid alternative to observational methods (Kunter & Baumert, 2006). However, for students' engagement in learning from texts with instructional pictures, it would be very desirable to complement the self-report data reported here, which can be prone to response biases such as social desirability, with more objective observational data (for example, time

spent on task, engagement in class). In addition, it would of course be worthwhile to investigate the relationships between students' engagement and students' abilities as measured by objective tests.

From a theoretical perspective, teachers' pedagogical beliefs and instructional behaviors are unlikely to exert uniform effects on all students. Rather, the important factor is the interaction between teaching behavior and students' needs. The very same instructional intervention can either foster or undermine student engagement, depending on its fit with a student's personal goals. For example, Kunter et al. (2007) have shown that the effects of teaching behaviors are mediated by students' perceptions of instructional features, which are, in turn, influenced by characteristics of the student and the context. Accordingly, future studies should incorporate measures of students' personal goals. From a methodological point of view, incorporating students' goals and their subjective experience of the teaching situation can be expected to reduce the error variance on the student level and to strengthen the effects of teacher characteristics on motivational outcomes. From a theoretical point of view, incorporating these variables would make it possible to test more comprehensive theories of the relationships between teachers' beliefs, instructional behaviors, and students' engagement in learning from texts with instructional pictures. The results of the present study indicate that these endeavors would be very worthwhile.

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Table 1
Sample items, reliability estimates (Cronbach's α), descriptive statistics, and intercorrelations of of the scales of the teacher questionnaire about beliefs on instructional pictures

	Descriptive statistics					Intercorrelations		
Scale	Sample item	N	α	M	SD	1	2	3
1. Utility of Pictures (3 items)	It is generally useful to combine pictures with texts in instruction to help students grasp the content.	108	.67	3.63	0.40			
2. Importance of Practice (4 items)	It is important to give students practice in reading and understanding pictures of varying levels of complexity that are integrated in texts.	107	.85	3.36	0.50	-.10		
3. Independent Learning (3 items)	Teachers should encourage their students to develop their own interpretations of texts with integrated pictures.	108	.70	3.31	0.48	-.13	.06	
2. Strategy Use (4 items)	Students become good readers of texts if they keep practicing certain strategies for dealing with texts and pictures.	103	.76	3.09	0.50	.07	.31**	.29**

** $p < .01$.

Table 2
Sample Items, Reliability Estimates (Cronbach's α), descriptive statistics, and intercorrelations of the scales of the teacher questionnaire about beliefs on reading comprehension

	Descriptive statistics					Intercorrelations		
Scale	Sample item	N	α	M	SD	1	2	3
1. Fostering Reading Competence (5 items)	Every teacher should foster students' reading competency.	108	.81	3.58	0.46			
2. Importance of Practice (4 items)	It is important to give students practice in reading and understanding texts of varying levels of complexity.	106	.81	3.54	0.44	.44**		
3. Independent Learning (3 items)	Teachers should encourage their students to develop their own interpretations of a text.	105	.73	3.27	0.51	.28**	.18	
4. Strategy Use (4 items)	One should teach students fixed strategies which can be used for every text.	105	.74	3.06	0.44	.16	.36**	.21*

* $p < .01$, ** $p < .01$.

Table 3
Sample items, reliability estimates (Cronbach's α), descriptive statistics, and intercorrelations of the scales of the student Questionnaire

	Descriptive statistics					Intercorrelations	
Scale	Sample item	N	α	M	SD	1	2
1. Classroom Management (5 items)	Students mess around a lot in biology classes.	108	.96	2.45	0.57	-	
2. Discussion Time (4 items)	In biology, we check that we have understood everything presented in pictures in class discussion.	108	.90	3.11	0.39	.38**	
3. Adaptive Explanations (5 items)	Our biology teacher explains everything presented in pictures in a way that all students are able to understand.	108	.91	2.89	0.42	.43**	.67**

** $p < .01$.

Table 4
Intercorrelations of the three identical scales of the teacher beliefs on instructional pictures and text reading

	Text reading		
Instructional pictures	Importance of Practice	Independent Learning	Strategy Use
Importance of Practice	.33**	.02	.17
Independent Learning	.14	.52**	.13
Strategy Use	.23*	.17	.50**

** $\underline{p} < .01$.

Table 5
Summary of multilevel regression analyses for variables predicting students' engagement in learning from texts with instructional pictures

	Model 1			Model 2		
Parameter	Estimate	SE	t(103)	Estimate	SE	t(101)
Intercept (German) [a]	2.38	0.05	45.44**	2.33	0.04	61.31**
Biology vs. German [b, c]	-0.04	0.07	-0.52	0.03	0.06	0.56
Geography vs. German [b, c]	-0.05	0.07	-0.76	0.03	0.06	0.62
Teacher beliefs						
Utility of Pictures [b, d]	-0.14	0.10	-1.47	-0.05	0.06	-0.79
Importance of Practice [b, d]	-0.04	0.06	-0.71	-0.03	0.05	-0.66
Independent Learning [b, d]	-0.14	0.07	-1.99*	-0.02	0.05	-0.29
Strategy Use [b, d]	0.13	0.06	2.41*	-0.01	0.05	-0.22
Instructional behavior						
Classroom Management [b, d]				0.16	0.04	3.54**
Discussion Time [b, d]				0.04	0.10	0.40
Adaptive Explanations [b, d]				0.51	0.07	6.87**
	Variance component		χ^2	Variance component		χ^2
Level 1	0.45			0.37		
Level 2[e]	0.02		88**	0.00		53
Level 3[a]	0.04		103**	0.01		59

[a] df = 45; [b] df = 103; [c] dummy coded (German as reference category); [d] variable centered at the grand mean, [e] df = 58.
* $p = .05$. ** $p = .01$ (two-tailed).

Table 6
Summary of multilevel regression analyses for teacher beliefs predicting teachers' instructional behavior

	Classroom Management			Discussion Time			Adaptive Explanations		
Parameter	Estimate	SE	t(101)	Estimate	SE	t(**101**)	Estimate	SE	t(**101**)
Intercept (German) [a]	2.45	0.08	30.33**	3.20	0.05	68.46**	2.99	0.05	56.57**
Biology vs. German [b]	-0.03	0.09	-0.40	-0.07	0.07	-1.03	-0.11	0.07	-1.64
Geography vs. German [b]	0.01	0.07	0.08	-0.19	0.07	-2.84**	-0.17	0.08	-2.16*
Teacher beliefs									
Utility of Pictures [c]	-0.10	0.11	-0.93	-0.20	0.07	-2.86**	-0.13	0.09	-1.47
Importance of Practice [c]	0.04	0.08	0.41	-0.10	0.06	-2.04*	-0.04	0.06	-0.68
Independent Learning [c]	-0.15	0.10	-1.55	-0.24	0.07	-3.24**	-0.16	0.08	-2.00*
Strategy Use [c]	0.25	0.07	3.54**	0.16	0.07	2.15*	0.19	0.07	2.69**
	Variance component		χ^2	Variance component		χ^2	Variance component		χ^2
Level 1	0.12			0.05			0.06		
Level 2[a]	0.19		209**	0.08		99**	0.11		101**

[a] df = 45; [b] dummy coded (German as reference category); [c] variable centered at the grand mean.
* p = .05. ** p = .01 (two-tailed)

Table 7
Indirect relationships (Sobel's z-test) between teachers' beliefs and students' engagement in learning from texts with instructional pictures mediated by teachers' instructional behavior

	Instructional behavior		
Teacher belief	Classroom Management	Discussion Time	Adaptive Explanations
Utility of Pictures	0.90	0.40	1.44
Importance of Practice	0.41	0.39	0.68
Independent Learning	1.42	0.40	1.92
Strategy Use	2.50*	0.39	2.50*

* $p < .05$ (two-tailed).

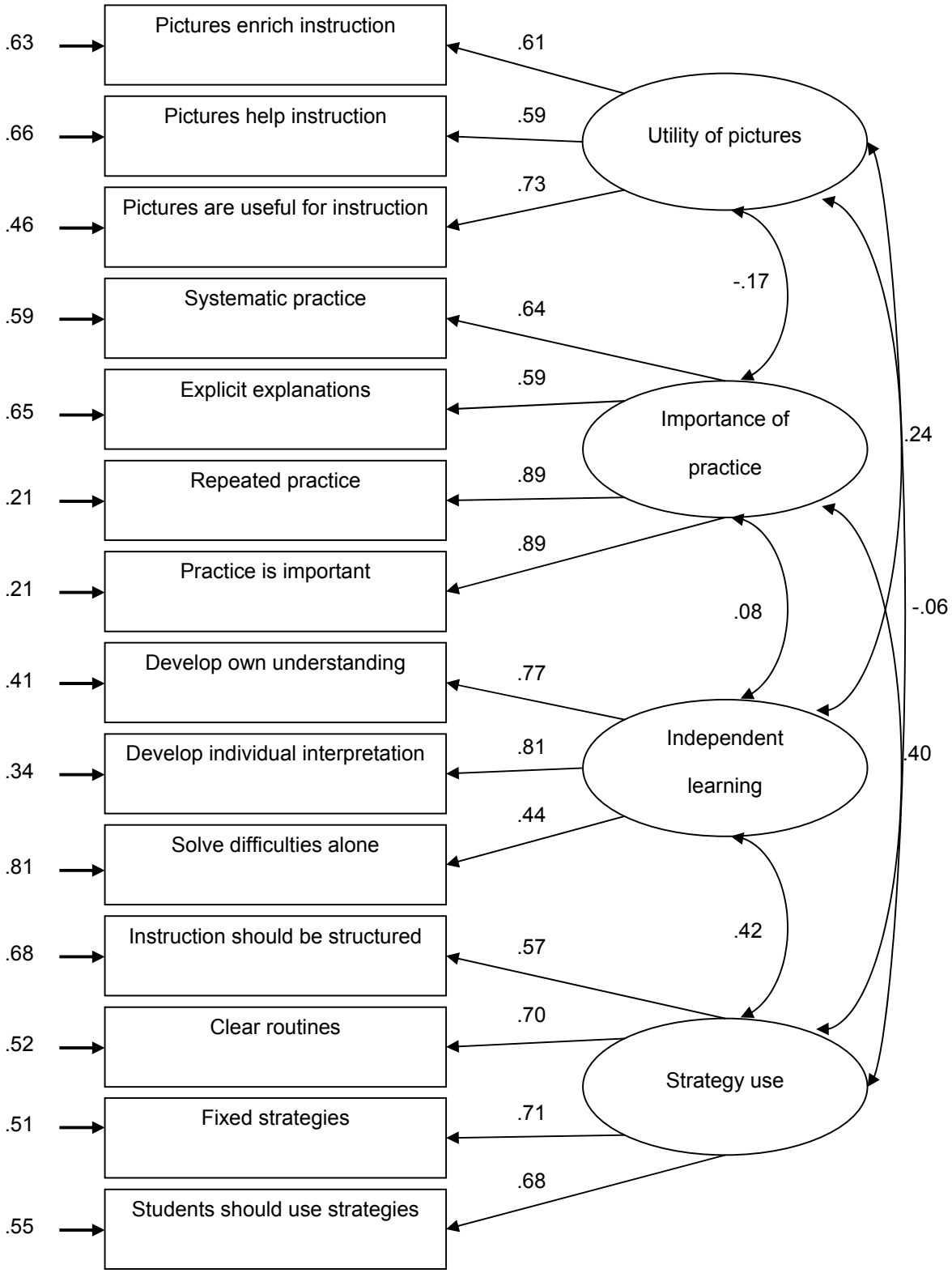

Fig. 1. Parameter estimates of the measurement model for the teacher belief scales (confirmatory factor analysis, standardized solution).

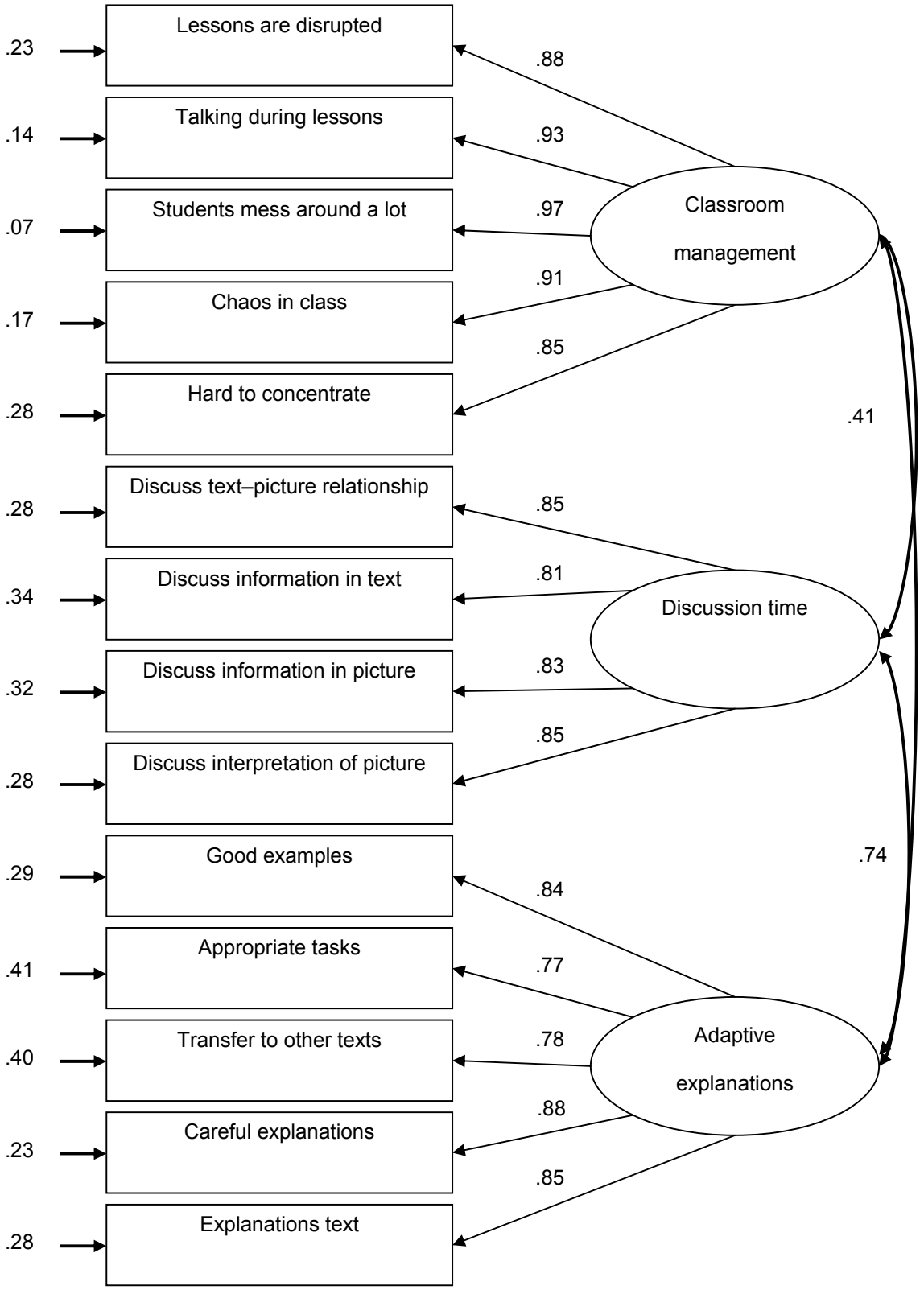

Fig. 2. Parameter estimates of the measurement model for the instructional behavior scales (confirmatory factor analysis, standardized solution).

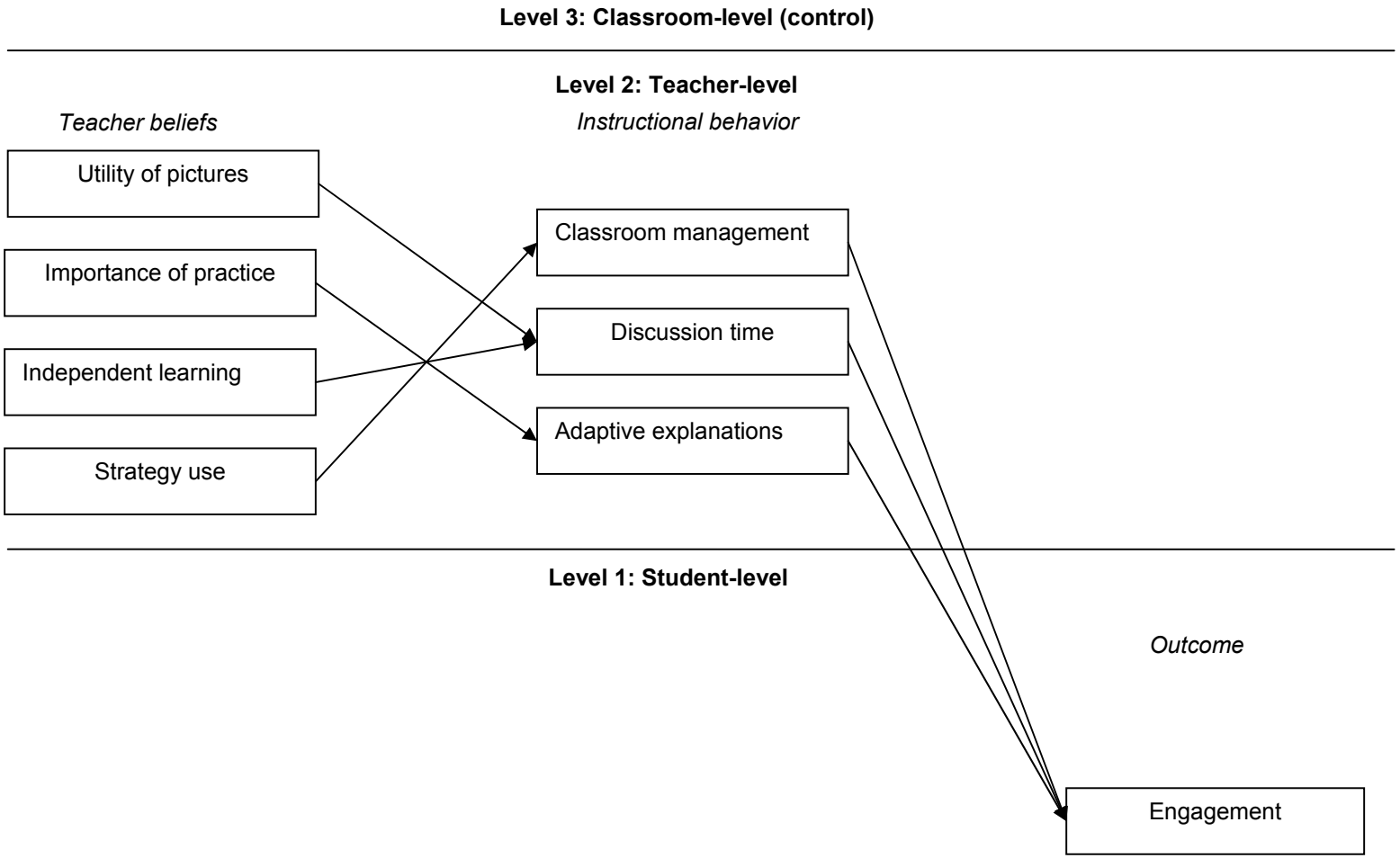

Fig. 3. Multilevel mediation model with teachers' beliefs as predictor variables and their instructional behaviors as mediator variables at Level 2 (teacher level) and students' engagement as the outcome variable at Level 1 (student level). The class level was included at Level 3 to separate variance components due to classes and due to teachers.